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Riding Dark Matter Waves at Windchime: Probing Ultralight Dark Photon Dark Matter with Optomechanical Sensors

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The Windchime Project aims to search for ultraheavy dark matter ($m \sim 10^{19}$ GeV) by leveraging advancements in quantum sensing technology, striving to detect dark matter through its gravitational interaction alone. However, dark matter could instead exist as an ultralight bosonic particle ($m < \text{eV}$), and it has recently been shown that the same technology could be used to detect dark matter in this ultralight regime. In this talk, we will show how an array of optomechanical sensors can be used to place leading bounds on ultralight dark photon dark matter. We will introduce the Windchime concept as it relates to measuring the wave-like signatures that such dark matter is expected to produce. Using this setup, we will demonstrate that Windchime will be sensitive to as-yet unprobed regions of the ultralight dark photon parameter space, surpassing the sensitivities of fifth-force experiments. Our results indicate that the Windchime experiment is set to be a powerful and versatile dark matter detector, tackling the dark matter puzzle from both mass extremes.

Submitted on behalf of a Collaboration?

Yes

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